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ORAL COMMUNICATION

Quality evaluation of dry-cured shoulder from different genetic lines of Iberian pigs

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Additional keywords

Retinto.
Entrepelado.
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Quality parameters.

SUMMARY

In this work the comparative quality of dry cured shoulders was studied from different genetic lines: Retinto x Entrepelado RxT (n=6), Torbiscal TxT (n=6), Entrepelado ExE (n=10), Retinto RxR (n=6) and Entrepelado x Torbiscal TxE/ExT (n=8). Dry-cured shoulders were evaluated w1tr EVACAL method, an original method from SiPA. This method includes physico-chemical analys1s (moisture, intramuscular fat, proteins, NaCl, myoglobin, fatty acid profile, volatile compound s and lipid oxidation), instrumental analysis (instrumental colour, pH and texture) and sensory analysis. The obtained results exposed that RxR batch shows a hígher ratio in oleic/steric and MUFAISAT, which is related with a high quality. This was confirmed in the sensory analysis with high scores of fat fluidity and lean brightness. The TxE/ExT batch is characterized by high quantities of myoglobin which resulted in high quantities of volatile compounds from aminoacid (2-metylbutanal y 3-metylbutan al). These facts were shown in the sensory analysis results with higher flavour persistence and higher juiciness in comparison with the other batches. Moreover, RxE batch reveals a high quantity oí intramuscular fat and higher scores in sensory attributes regarding the appearance (fat fluidity), texture (juiciness) and odour intensity in comparison with the other batches. We can conclude that there are three genetics lines which result in high quality products. The convenience of using one of these depends on other aspects like the prolificacy.

Evaluación de la calidad de las paletas curados de diferentes líneas genéticas de cerdos Ibéricos

Palabras clave adicionales

Retinto.
Entrepelado.
Torbiscal.
Parametros de calidad.

RESUMEN

En este trabajo se estudió la calidad comparativa de las paletas curados de diferentes líneas genéticas: Retinto x Entrepelado RxT (n = 6), TxT Torbiscal (n = 6), Entrepelado ExE (n = 10), Retinto RxR (n = 6) Y Entrepelado x Torbiscal TxE/ExT (n = 8). Las paletas curadas se evaluaron con el método EVACAL, un método original del SiPA. Este método incluye análisis físico-químicos (humedad, grasa intramuscular, proteínas, NaCl, mioglobina, perfil de ácidos grasos, compuestos volátiles y oxidación de lípidos), análisis instrumental (color instrumental, pH y textura) y análisis sensorial. Los resultados obtenidos revelaron que el lote RxR muestra una relación más alta en oleico / estérico y MUFA/SAT, que se relaciona con una alta calidad. Esto se confirmó en el análisis sensorial con altas puntuaciones de fluidez grasa y brillo del magro. El lote TxE/ExT se caracteriza por presentar unos valores elevados de mioglobina que producen grandes cantidades de compuestos volátiles a partir de aminoácidos (2-metilbutanal y 3-metilbutanal). Esto hecho se mostró en los resultados del análisis sensorial con una mayor persistencia de sabor y mayor jugosidad en comparación con los otros lotes. Por otra parte, el lote RxE revela una gran cantidad de grasa intramuscular y mayores puntuaciones en atributos sensoriales en cuanto a la apariencia (fluidez grasa), textura (jugosidad) e intensidad de olor en comparación con los otros lotes. Podemos concluir que existen tres líneas genéticas que pueden producir productos de alta calidad. La conveniencia de utilizar uno de estos depende de otros aspectos como la prolificidad.

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INTRODUCTION

The quality of meat and meat products of the Iberian pig has been widely studied by many authors, pointing out the parameters that have the most influence. In the case of cured products such as dry cured ham and shoulder, we have studied the influence on quality from different points of view: food, genetics, processing, etc. Regarding the genetic base, it is very important to obtain a genetic line that represents a greater prolificacy and performance of noble pieces, without impairing the quality of the product. Within a single breed, when comparing different lines or strains, one can observe variations in parameters that define

the quality of fresh meat and of cured products derived from pigs. Within a collaboration of the IRTA and the (Innovation Service in Animal Products) SiPA the quality of dry cured shoulders from pigs of three different genetic lines: Retinto, Torbiscal and Entrepelado and its crosses. The study of the quality of dry cured shoulders was approached according to the EVACAL protocol developed by the SiPA. Thus the pieces received were subjected to a battery of physical-chemical and instrumental analysis, and the data obtained were statistically treated to establish significant differences and to see their impact on the quality of the product.

MATERIAL AND METHODS

A total of thirty-six dry-cured shoulder from five different batches were analized.

The batches were:

Retinto x Entrepelado, RxT (n=6)

Torbiscal, TxT (n=6)

Entrepelado, ExE (n=10)

Retinto, RxR (n=6)

Entrepelado x Torbiscal: TxE/ExT (n=8)

The batches correspond to animals with a slaughter age of 310-360 days (10-12 months), some of which may reach up to 440 days, with a slaughter weight between 12.8@ and 14.9@ (14@). The feed was the same for all batches.

Methodology for sampling

At the reception of the dry-cured shoulder, using an electric saw, the pieces were divided into three parts, the central region of about 15 cm we analyzed in the UEX to perform the EVACAL method and the other two parts that are sent to the IRTA for their sensory evaluation through a consumer test. After the samples were collected they were vacuum packed and kept in refrigeration (or freezing) until analysis.

Methods for physical-chemical and instrumental analysis

Physical-Chemical and Instrumental Analysis

Determination of proximal composition: moisture, intramuscular fats, proteins and chlorides (AOAC methods, 2000).

Determination of myoglobin and heminic iron content by the method described by Hornsey et al. (1956).

Determination of the fatty acid profile by gas chromatography with flame ionization detection (GC-FID). Methyl esters of fatty acids are prepared by mixed transesterification, according to (Lopez-Bote et al. 1997)

Determination of aromatic compounds by solid phase microextraction (SPME) of volatile compounds and analysis by gas chromatography coupled to mass spectrometry (GC-MSD) detection (Ruiz et al. 1998)

Determination of lipid oxidation, through the quantification of products derived from lipid oxidation by extraction of reactive substances from thiobarbituric acid and subsequent spectrophotometric analysis (Rosmini et al. 1996)

Determination of instrumental colour using the Minolta colorimeter. The parameters a *, b * and L * are indicators of "red", "yellow" and "brightness" respectively.

Determination of pH by electrometry.

Determination of instrumental texture through the development of the protocols described by Bourne (1978) for a Universal texturometer TA-XT2i (Stable Micro Systems, Godaliming, UK)

Sensory analysis

It will consist of a quantitative-descriptive analysis performed by a tasting panel trained according to the protocol developed by our research group (García et al. 1996). 14 panellists will evaluate a slice 1 mm thick from the central area of the boneless trowel (as is done for the Serrano Ham TSG). Dry cured shoulders will be evaluated for several days, evaluating 3 dry cured shoulders per session. The attributes analyzed are related to the appearance (yellow colour of fat, pink colour of the fat, redness of lean, brightness lean and marbling), texture (hardness of fat, fluidity of fat, hardness of lean, juiciness, pastiness and dryness), flavour (saltiness, acidity, sweetness, bitterness, umami, flavour intensity, flavour persistence, cured flavour and rancid flavour).

Statistical Analysis of Results

The treatment of anomalous data was carried out using the Grubb test, recommended by ISO standards. For the statistical analysis a multivariate analysis was carried out using the SPSS software package (v.12.0).

RESULTS AND DISCUSSION

The Physical – chemical parameters, **Table I**, stand out due to the absence of significant differences in all parameters for the five batches compared. The level of dehydration of the dry cured shoulders is between 50% and 56%, the normal in this type of products is slightly less than 50%. The salt level is around 3.5-4.0% in fresh, except the ExE batch, in which the value is quite low for this type of product, but in any case above the critical limit of 2%. This is a level of salt adequate to do the descriptive quantitative sensory analysis, since in previous studies on cured dry cured shoulders with a percentage of fresh NaCl in the order of 5.5% (less than 6.5% found in other studies), some attributes are masked in sensory analysis. In any case, it is a level of fresh salt below 4.5%, a level above which some have reported that Iberian ham is salted (Ventanas et al. 2007).

As for the level of intramuscular fat, the RxT and ExT batches present a higher value. It must be taken into account that this parameter is very important in the quality, since they directly influence the juiciness and brightness of the product, thus generating volatile compounds responsible for the odour and flavour during the curing process of the mentioned products.

Table I. Physical – chemical analysis of the dry cured shoulders from different genetics lines of Iberian pigs (Retinto, Entrepelado and Torviscal) (Análisis físico – químico de paletas curadas procedentes de diferentes líneas genéticas de cerdo Ibérico (Retinto, Entrepelado and Torviscal)).

	RxE	TxT	ExE	RxR	TxExExT	P
% Moisture	56.3±1.29	54.48±3.06	51.11±9.25	51.8±3.12	56.5±0.39	ns
% Chlorides (NaCl) (f)	3.9±0.38	3.82±0.89	2.92±0.62	3.12±0.24	3.63±105	ns
% Chlorides (NaCl) (s)	8.91±0.66	8.33±1.41	5.99±0.67	6.49±0.64	8.32±2.34	ns
% Chlorides (NaCl) (s,dg)	11.08±1.75	9.78±1.65	7.17±0.95	7.29±0.4	9.64±2.62	ns
% Fat (f)	8.32±3.09	6.37±0.83	6.78±1.29	7.23±2.85	8.09±2.11	ns
% Fat (s)	18.92±6.49	14.74±2.52	16.23±4.72	11.07±5.11	13.86±2.67	ns
% Proteins (f)	28.71±0.58	29.07±1.55	30.77±2.51	29.9±2.28	28.28±0.52	ns
% Proteins (s)	66.04±3.03	63.84±7.3	62.11±6.72	65.77±3.86	65.02±0.85	ns
% Proteins (s,dg)	81.72±6.02	74.91±8.61	74.58±11.97	74.13±6.04	75.55±3.11	ns
mg Mb/g m	5.77±1.52^{a}	5.62±1.02^{a}	5.43±0.98^{a}	5.58±0.99^{a}	9.05±1.61^{b}	*
ppm Fe heminic	19.58±5.15^{a}	19.08±3.46^{a}	18.42±3.34^{a}	18.94±3.37^{a}	30.71±5.46^{b}	*

*P: level of significance < 0.05.

At the level of myoglobin significant differences are detected in one batch with respect to the others, it is the batch ExT / TxE that presents an elevated value of 0.9% and the rest of batches oscillate between 0.54-0.58%. This parameter is intimately linked to the quality of the product (Ventanas et al. 2007, 2008), presenting in all cases a higher value than in Iberian ham (0.3-0.4%), and of course that in white pig. The effect of genetics, which is fundamental in this parameter, but it is difficult to explain with this argument a nearly double increase of the ExT / TxE batch, for which would have to be thought of younger animals and with a very important extensivity regime.

In the instrumental analysis of **Table II**, the pH is slightly above the normal value (<6). This fact is in principle negative because it can be a starting raw material with a risk of microbiological alteration and from the technological point of view the pH value may suggest a anomalous post-mortem process, which could have negative implications on the final quality of the meat or meat product; Especially highlighting the pH value of the ExT / TxE batch, in any case it would be interesting to know the pH at 24h to establish better anomalies directly related to the pH.

Regarding the value of TBA are slightly higher than in other studies on Iberian dry cured shoulder, in any case this parameter is due to several factors such as: IMF levels, balance of prooxidant agents and antioxidants in said product. In any case the values are not abnormally high.

The "a" value (redness) was slightly higher in the RxE batch, but it is not very important because the sensorial analysis does not show significant differences in the red colour value. Curiously, the TxE / ExT batch that presented a greater amount of myoglobin does not manifest itself in the "a" value, but we must bear in mind that these instrumental colour parameters are especially suitable for fresh meat. The value of "L" (brightness) is quite superior to the palettes of the first study; this fact is in line with the fact that the dry cured shoulder of this study also presents more humidity.

Table III shows the fatty acid profile from the intramuscular fat of the four batches analyzed. The notable note is the absence of statistically significant differences for most of the fatty acids studied, and especially in the amount of saturated, monounsaturated and polyunsaturated. However, the genetic line R is the one that presents, in absolute terms, a higher level of AGMI, reason why we can understand that the activity of stearil

Table II. Instrumental analysis of the dry cured shoulders from different genetics lines of Iberian pigs (Retinto, Entrepelado and Torviscal) (Análisis instrumental de paletas curadas procedentes de diferentes líneas genéticas de cerdo Ibérico (Retinto, Entrepelado and Torviscal)).

	RxE	TxT	ExE	RxR	TxExExT	P
L	40.56±2.48	42.48±2.24	44.03±3.41	43.99±3.28	43.85±2.22	ns
a	16.17±0.82^{b}	12.89±2.14^{a}	13.16±2.71^{a}	13.82±1.33^{ab}	13.3±1.37^{ab}	*
b	5.73±1.53^{b}	4.35±2.09^{ab}	3.54±0.9^{a}	3.1±0.55^{a}	3.86±0.84^{ab}	*
mg MDA/Kg	0.34±0.03	0.35±0.03	0.34±0.05	0.39±0.03	0.35±0.02	ns
pH	6.13±0.06^{a}	6.19±0.11^{a}	6.3±0.12^{ab}	6.21±0.11^{a}	6.46±0.1^{b}	*
aw	0.88±0.01	0.88±0.02	0.89±0.01	0.9±0.01	0.89±0.01	ns

*P: level of significance < 0.05

Table III. Fatty acid profile of the dry cured shoulders from different genetics lines of Iberian pigs (Retinto, Entrepelado and Torviscal) (Perfil de ácidos grasos de paletas curadas procedentes de diferentes líneas genéticas de cerdo Ibérico (Retinto, Entrepelado and Torviscal)).

	RxE	TxT	ExE	RxR	TxExExT	P
% C14	1.23±0.08	1.31±0.37	1.19±0.06	1.2±0.09	1.23±0.16	ns
% C16	24.62±0.94	24.07±0.68	24.87±0.7	24.06±0.98	25.15±0.97	ns
% C16:1	3.54±0.36	3.46±0.42	3.48±0.43	3.61±0.49	3.34±0.3	ns
% C17	0.22±0.03	0.34±0.17	0.23±0.05	0.21±0.05	0.23±0.1	ns
% C17:1	0.4±0.15	0.52±0.24	0.39±0.12	0.46±0.16	0.34±0.07	ns
% C18	10.42±0.8	10.71±0.93	11.09±0.77	10.39±1.51	10.65±0.28	ns
% C18:1	50.72±1.01	50.62±2.21	50.51±1.07	51.14±2.22	50.43±0.87	ns
% C18:2(n-6)	7.36±1.29	7.15±1.17	7.18±0.49	7.6±0.77	7.19±0.74	ns
% C18:3(n-3)	0.33±0.08	0.45±0.22	0.33±0.05	0.36±0.18	0.33±0.06	ns
% C20:1	0.75±0.14^{ab}	0.9±0.28^{b}	0.76±0.1^{ab}	0.8±0.15^{ab}	0.62±0.13^{a}	*
% C20:4 (n-6)	0.28±0.12^{a}	0.5±0.17^{b}	0.39±0.06^{ab}	0.41±0.1^{ab}	0.31±0.05^{ab}	*
%SFA	9.1±0.41	9.09±0.28	9.31±0.29	8.93±0.61	9.32±0.29	ns
%MUFA	55.4±1.24	55.38±1.73	55.14±1.25	55.95±2.69	54.73±0.78	ns
%PUFA	7.59±1.39	7.46±1.33	7.42±0.46	7.87±0.74	7.43±0.77	ns

*P: level of significance < 0.05

Δ9-desaturase in the case of the other batches could have a lower enzymatic activity, as can be seen in the C18: 1 (oleic) / C18: 0 (stearic) ratio, which is higher in the Retinto than the other two, indicating that the stearyl Δ9-desaturase may be more active in the retinoids, favouring the synthesis of oleic acid. Regarding the AGPI values have levels <10%, which is interesting from the technological point of view. Finally, the levels of n-6 and n-3 practically remain between the 3 batches, which is logical if the breeding of the animals in terms of diet and feeding has been equivalent.

In **Table VI**, the values in U.A. (10^6) of the most representative volatile compounds extracted by SPME and analyzed by GC-MS. For a better visualization of the data, volatile compounds grouped according to their origin, lipids (LIP) or amino acids (AA) are presented.

Table IV. Volatile profile of the dry cured shoulders from different genetics lines of Iberian pigs (Retinto, Entrepelado and Torviscal) (Perfil de compuestos volátiles de paletas curadas procedentes de diferentes líneas genéticas de cerdo Ibérico (Retinto, Entrepelado and Torviscal)).

	RxE	TxT	ExE	RxR	TxExExT	P
2-metilpropanol	1672.25±151.48	1620.25±121.86	1839±204.04	1837.75±570.13	1331.75±236.94	ns
Heptanal	5.29±0.71	4.44±1.15	5.35±1.8	5.51±0.6	4.46±1.7	ns
2.4-dimetilpentanol	70.11±12.12^{b}	44.84±9.07^{a}	42.16±8.88^{a}	60.79±10.43^{ab}	51.93±12.63^{ab}	*
5-metilhexanal	3.52±0.74	2.89±1.01	3.39±1.47	3.4±1.61	4.47±2.42	ns
Octanal	1.57±0.18	1.28±0.33	1.6±0.42	1.72±0.57	1.23±0.16	ns
1-Pentanol	14.74±2.17	11.31±8.56	12.06±5.22	17.25±8.7	9.97±4.02	ns
Nonanal	2.61±0.35	3±0.76	3±0.8	3.03±1.06	2.22±0.29	ns
3-methylbutanal	256.18±59.77^{ab}	239.5±39.79^{ab}	179.58±18.8^{a}	245.88±35.77^{ab}	294.9±82.51^{b}	*
Hexanal	133.41±32.78	99.91±15.85	138.63±65.15	119.52±58.71	152.46±67.5	ns
1-Hexanol	15.63±4.6	10.46±10.35	11.99±7.17	18.59±12.63	9.02±1.55	ns
Butanal	26.35±3.15^{ab}	22.07±4.01^{ab}	29.34±6.22^{b}	27.19±6.74^{ab}	18.51±2.48^{a}	*
2-metilbutanal	165.98±20.85	149.2±52.68	127.63±12.17	176.83±65.33	168.1±47.62	ns
2-Heptanona	36.26±11.04	29.87±28.61	32.94±25.37	53.17±49.27	19.91±7.56	ns
Pentanal	55.29±10.81	42.27±13.63	49.67±21.1	47.88±30.15	80.74±38.35	ns
2-metilpropanal	803.98±83.78	763.68±61.64	913.15±74.65	847.6±257.67	633.83±91.31	ns
Propanal. 2-methyl-	561.38±47.97	608.73±223.31	496.65±57.66	663.75±220.3	610.35±214.82	ns
AA	1789.52±86.97	1764.39±92.17	1720.98±73.24	1938.4±67.33	1711.47±77.52	ns
LIP	2032.95±120.97	1889.54±107.12	2164.15±97.42	2188.52±130.37	52	ns
AA/LIP	0.88	0.93	0.80	0.89	1.02	

*P: level of significance < 0.05

Table V. Sensory analysis of the dry cured shoulders from different genetics lines of Iberian pigs (Retinto, Entrepelado and Torviscal). (Análisis sensorial de de paletas curadas procedentes de diferentes líneas genéticas de cerdo Ibérico (Retinto, Entrepelado and Torviscal)).

ATRIBUTES	RxE	TxT	ExE	RxR	TxExExT	P
Yellow colour fat	2.5±0.5^{c}	1.94±0.35^{b}	1.31±0.35^{a}	1.55±0.23^{ab}	1.36±0.18^{a}	*
Pink fat	1.42±0.36^{a}	2.52±0.53^{b}	1.66±0.33^{a}	3±0.71^{b}	2.62±0.34^{b}	*
Fluidity of fat	6.63±0.38^{c}	5.99±0.38^{abc}	5.37±0.55^{a}	6.28±0.2^{bc}	5.69±0.43^{ab}	*
Redness of lean	6.82±0.58	7.03±0.43	6.65±0.76	6.28±0.37	6.75±0.31	ns
Brightness lean	2.78±0.4^{ab}	3.36±0.31^{bc}	3.57±0.69^{bc}	3.88±0.78^{c}	2.41±0.31^{a}	*
Hardnee s lean	2.78±0.42^{b}	2.14±0.5^{a}	2.53±0.321^{ab}	2.48±0.32^{ab}	2.8±0.46^{b}	*
Marbling	4.23±0.31^{a}	4.96±0.09^{b}	4.17±0.5^{a}	5.65±0.38^{c}	4.29±0.48^{a}	*
Odour	6.85±0.26^{b}	6.02±0.53^{a}	5.95±0.59^{a}	5.89±0.71^{a}	5.76±0.2^{a}	*
Hardness	2.71±0.48^{ab}	2.99±0.43^{ab}	3.17±0.6^{b}	3.09±0.45^{ab}	2.42±0.34^{a}	*
Dryness	1.5±0.34^{a}	2.19±0.45^{bc}	1.58±0.36^{a}	2.42±0.28^{c}	1.68±0.24^{ab}	*
Juiciness	6.24±0.19^{c}	5.3±0.46^{a}	5.41±0.41^{ab}	5.59±0.44^{abc}	6.02±0.6^{bc}	*
Pastiness	3.78±0.23^{c}	2.59±0.33^{ab}	2.99±0.6^{a}	3.36±0.32^{bc}	3.29±0.4^{bc}	*
Saltiness	4.76±0.28^{b}	4.9±0.29^{b}	5.18±0.42^{b}	4.98±0.37^{b}	3.26±0.43^{a}	*
Sweetness	2.06±0.21^{b}	1.59±0.23^{a}	1.76±0.35^{ab}	2.14±0.36^{b}	1.5±0.27^{a}	*
Bitterness	1.25±0.41^{ab}	1.01±0.2^{a}	1.59±0.36^{bc}	1.99±0.34^{c}	1.27±0.3^{ab}	*
Umami	1.92±0.14^{a}	2.33±0.24^{ab}	2.25±0.38^{ab}	2.98±0.5^{c}	2.69±0.37^{bc}	*
Intensity	5.78±0.41	5.85±0.31	5.9±0.45	6.02±0.28	5.97±0.25	ns
Persistence	4.73±0.48^{a}	4.47±0.36^{a}	4.62±0.45^{a}	5.43±0.53^{b}	5.82±0.26^{b}	*
Cured flavour	4.23±0.6^{a}	5.03±0.33^{b}	4.76±0.28^{ab}	4.77±0.22^{b}	4.88±0.37^{b}	*
Rancid flavour	1.5±0.39^{a}	1.43±0.42^{a}	1.58±0.25^{ab}	1.84±0.28^{ab}	2.05±0.31^{b}	*

*P: level of significance < 0.05.

The most significant fact is the absence of significant differences for virtually all parameters except for two volatile compounds derived directly from the degradation of amino acids (and therefore with notes to curing), probably related to the greater amount of myoglobin, such that The Ext / TxE lot has the highest values.

Table V. shows the results of descriptive quantitative sensorial analysis (ACD) with trained tasters. In this analysis, the high number of parameters with significant differences is highlighted. In the case of the RxE batch, the higher values of "yellow fat", "fat fluidity", "odour intensity" and "juiciness", are directly related to the fact that this batch has the highest amount of intramuscular fat, although it does not present a predominance of MUFA. However, it does not stand out for its notes to cure, as suggested by the ratio of AA / LIP volatile compounds, which is one of the lowest. On the other hand, the batches with genetic basis T (TxT and TxE / ExT), do present the highest scores for the "cured flavour" and "persistence" taxa coinciding with the AA / LIP ratios that indicate that these lots have a Greater balance of AA volatile compounds, and therefore compounds responsible for the curing notes of these products. In any case the intensity of the flavour is equivalent between the different batches. Overall, these results of sensory analysis indicate that although there are specific differences for certain attribute and between certain batches, in the global assessment of sensory analysis the five lots have an equivalent sensory quality. This is in line with the sensory study of acceptability carried out by Professor Dolors Guardia of the IRTA of Catalonia, which reveals that consumers do not distinguish between the five batches, presenting a non-differentiated acceptability value statistically between the different genetic lines.

CONCLUSIONS

RxR batch showed a higher ratio in oleic/steric and MUFA/SAT which is related with a higher quality. This was confirmed in the sensory analysis with high scores of fat fluidity and lean brightness. The ExT/TxE batch is characterised by high quantities of myoglobin which resulted in high quantities of volatile compound from aminoacid (2-metylbutanal y 3-metylbutanal). These facts were shown in the sensory analysis results with a higher flavour persistence and higher juiciness in comparison with the other batches. RxE reveals a high quantity of intramuscular fat and higher scores in sensory attributes regarding the appearance. texture and odour intensity in comparison with the other batches.

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